ATRC
ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

Project 572

November 2006

Evaluation of Benefits and Opportunities for Innovative Noise Barrier Designs

Background

Noise barriers have been used by the Federal Highway Administration (FHWA) and the Arizona Department of Transportation (ADOT) for over 30 years to reduce traffic noise levels for highway-adjacent residential areas and other noise-sensitive land uses. As traffic volumes and speeds have increased on highways, noise levels have risen for nearby homes, prompting transportation agencies to look for ways to provide more effective noise attenuation at a reasonable cost.

Noise barriers are typically constructed of cast-in-place concrete or masonry block. In some areas, where space allows and soil material is available, earth berms are constructed as noise barriers. The barriers effectively reduce noise levels, but often cause undesirable secondary impacts, such as blocked views of mountains and other scenic features, decreased visibility from the roadway, or large shadows cast across a resident's backyard for extended periods of the day. Raising noise barriers to achieve further noise reduction often exacerbates these secondary impacts.

Innovative noise barrier designs and treatments have been successfully implemented in other states and in other countries for a number of years. These innovative designs have allowed the initial construction of a noise wall to be lower in height than a conventional wall. These techniques have also been used to retrofit an existing noise barrier to achieve a higher level of noise reduction without substantially increasing the barrier height and at a much lower cost than replacing the barrier with a taller structure.

Methodology

Literature Review – The project initially focused on gathering existing literature on noise barrier materials and designs that were non-conventional. The intent was to identify innovative barrier designs that would have the potential to be implemented in Arizona. Literature was collected on dozens of noise barrier research projects in

12 countries around the world. Many of the barrier designs consisted of treatments to the top edge of the barrier to change or disrupt the diffraction pathway from the noise source to the receiver. A few innovative barrier materials were also included in the literature review.

Matrix Evaluation – The results of the previous research studies were compiled into a matrix to assist in evaluating the various barrier designs and materials. The evaluation matrix was used to score the barrier designs based on their acoustic performance, as well as economic, constructability, maintenance, and aesthetic considerations. The scores were weighted based on the potential reduction in barrier height and the results were ranked.

ADOT Approval Structure – To understand the approval structure, numerous informal interviews were conducted with several ADOT employees in the Environmental Planning Group (EPG), as well as in the Valley Project Management (VPM) and Statewide Project Management (SPM) groups. These interviews revealed that ADOT does not have a standard process for noise barrier selection and approval. Once the environmental process is completed and the project progresses toward final design, EPG is no longer involved in decisions and oversight of the recommended noise barriers. The individual project managers within VPM and SPM have the authority to select how to implement the noise barrier recommendations. The project managers select the design of the barriers and the materials that will be used to construct the barriers.

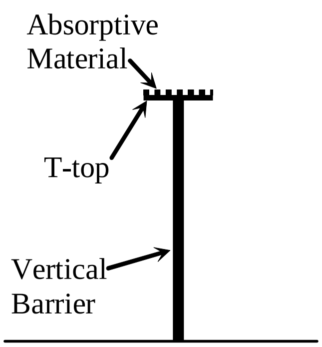
Public Acceptance Review – While technical performance is a key aspect of noise barrier design selection, other considerations are also important. One such consideration is whether or not a particular barrier design and appearance receives public acceptance. It is in this light that part of the initial objectives was to evaluate the extent to which the public would accept designs such as the ones just presented. However, following several unsuccessful attempts to implement such a public survey, it was decided it could not be completed in a timely manner as part of this effort. Nonetheless, it is worth emphasizing that efforts toward public “buy-in” of unconventional approaches ought to be considered during a project. In so doing, chances are much better that any concerns communities may have are eventually overcome.

Findings

The literature review and evaluation matrix revealed that the designs with the most potential were a T-top barrier design with absorptive material on the top and a barrier with absorptive material applied to the roadway side of the barrier.

A barrier design with active noise control was also highly rated as part of the matrix evaluation. However, the evaluation may not have completely factored in the additional cost of this type of barrier, as well as the fact that the design is still in the prototype stage and may not be feasible to implement on a large-scale at the present time. As a result, the active noise control barrier design was not recommended as part of the research project, but should be evaluated at a later date as technology in this area progresses and the design becomes more feasible.

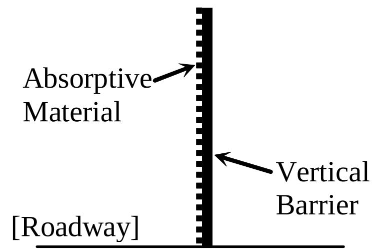
The T-top barrier design consists of a vertical barrier with a horizontal cap along the top edge of the barrier, creating a shape that resembles a "T". The horizontal portion of the barrier is approximately two to three feet wide and creates a double-diffraction pathway over the top of the barrier, thereby reducing noise levels compared to a vertical barrier of similar height. To increase the noise reduction potential of this barrier



T-top barrier design with absorptive material on top

design, an absorptive material is applied to the top of the horizontal portion of the barrier. Research has shown that this barrier design reduces noise levels by about 2 to 3 decibels, which could reduce barrier heights by approximately 4 to 6 feet, or about 5 feet on average.

The barrier with absorptive material consists of a vertical noise barrier with an absorptive material applied to the side of the barrier facing the highway traffic. This barrier reduces noise by absorbing noise and eliminating reflected noise off the face of the barrier. In addition, since the absorptive material is applied up to the top edge of the barrier, the diffracted noise over the top of the barrier is also reduced. Research results were less consistent with this barrier design, but typically showed noise level reductions by about 1 to 3 decibels. This barrier design has the potential to reduce barrier heights by about 2 to 5 feet, or about 3.5 feet on average. The application of this barrier design may be most appropriate in locations with a parallel barrier situation, or when the noise barrier is located in close proximity to the highway traffic.



Vertical barrier with absorptive material on roadway side

Recommendations

Based on the research and evaluation conducted for this study, it is recommended that two innovative barrier designs be considered by ADOT – 1) a T-top design with absorptive material placed on the top of the horizontal portion of the barrier and 2) a vertical barrier with absorptive material applied to the face of the barrier. These two barrier designs have been shown in the available literature to reduce noise levels by up to 3 decibels, which could reduce overall barrier heights by as much as 3 to 5 feet compared with a conventional noise barrier of concrete or masonry block construction. A noise barrier design that could provide comparable noise reduction at a substantially reduced barrier height will minimize some of the negative aspects of conventional noise barriers, such as blocked views and large areas in shadow for extended periods of the year.

Because ADOT does not employ a standard process for noise barrier selection and approval, it is also recommended that these results periodically be presented to and discussed with project managers. The Implementation Guide will provide a basis for this discussion.

The Implementation Guide establishes a set of criteria for those situations where the innovative barrier designs are most appropriate and should be considered. It was developed by the researchers to provide summary characteristics for the two specific innovative barrier designs being recommended.

The full report: **Evaluation of Benefits and Opportunities for Innovative Noise Barrier Designs**, by Dustin D. Watson, HDR Engineering, Inc. (Arizona Department of Transportation, report number FHWA-AZ-06-572, published November 2006) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.